Development of Fiber Reinforced Composite Feedstock for In-Space Manufacturing of High Strength Parts, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

GeoComposites, LLC, aims to develop the next generation of high performance fiber reinforced composite feedstock for in-space manufacturing of high strength parts via fused deposition modeling (FDM). Since plastics are inherently low in strength, additive manufactured plastic currently cannot compete with metallic parts. Failed parts on the International Space Station (ISS) and the genuine need for structural spare parts onboard ISS and for deep space missions mandates that composite feedstock and associated FDM payloads should be developed for future in-space manufacturing. GeoComposites will develop composite feedstocks and associated deposition parameters to meet the requirement set by NASA for an ultimate tensile strength of 200 MPa.

For a high strength part, it is not just sufficient to have a high strength feedstock but also a FDM facility that allows for the part build as dictated by the feedstock. GeoComposites proposes to demonstrate a combination of feedstocks for high strength parts. The part build will be performed with a dual nozzle FDM machine. The first feedstock will be created by extruding the mixture of a thermoplastic matrix with an optimized distribution of compatible chopped fibers. Continuity between the interlayer fibers will provide high bond strength between layers. The layup will combine this feedstock with continuous High Strength High Temperature (HSHT) fibers. Mechanical and outgas testing will be performed to demonstrate compatibility with NASA requirements.

In addition, we propose to analyze ISS accommodation of FDM equipment capable of printing structural parts on the ISS using the developed feedstocks. The overall proposed approach will provide a comprehensive solution to include development of the customized high strength feedstocks, layup pattern and build parameters, and an analysis of ISS accommodation for consistent in-space production of high strength composite parts.

Anticipated Benefits

High strength feedstocks and an ISS-compatible FDM machine will provide the path for:

· In-space manufacturing of structures, electronics, and tools;

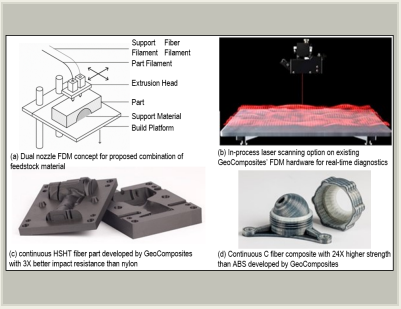
· Printed satellites, including CubeSats;

· Mass savings on Space Launch Systems by replacing metallic parts with composites;

· Printing of multifunctional radiation shielding material for crew health;

· In-space part design using digital twins validated by real time diagnostics;

· On-demand printing of food using cellulose based feedstocks.



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Non-NASA applications of FDM using high strength feedstock is expected to include:

· For the medical industry, products ranging from medical devices to cell culturing;

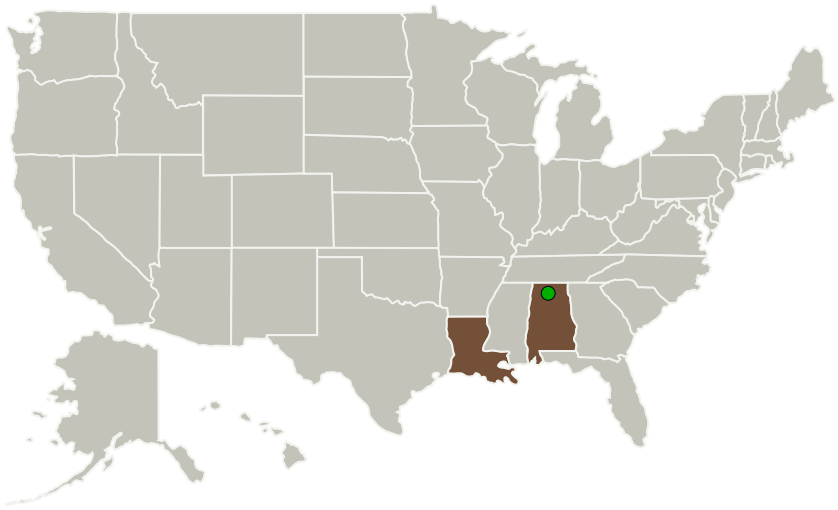
· For the aerospace industry, items like GE's commercial jet engine nozzle;

· For construction, fiber reinforced building material feedstock and Contour Crafting;

· For the automotive industry, lightweight printed composites to enhance fuel efficiency;

· For the Department of Defense, on demand printed parts in theater of operation.

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

GeoComposites, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

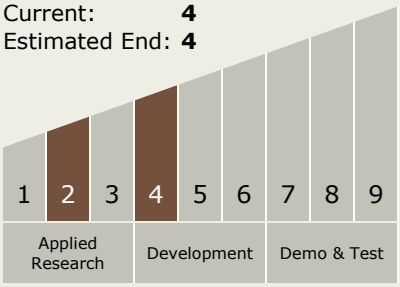
Carlos Torrez

Principal Investigator:

Sunil Patankar

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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Organizations Performing Work	Role	Type	Location
GeoComposites, LLC	Lead Organization	Industry	Metairie, Louisiana
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Louisiana

Project Transitions

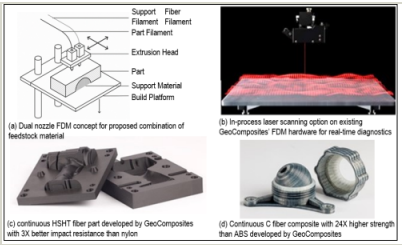
July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141012)*

Images



Briefing Chart Image
Development of Fiber Reinforced Composite Feedstock for In-Space Manufacturing of High Strength Parts, Phase I
(https://techport.nasa.gov/image/132273)

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.4 Manufacturing
    - TX12.4.1 Manufacturing Processes

Target Destination

Earth

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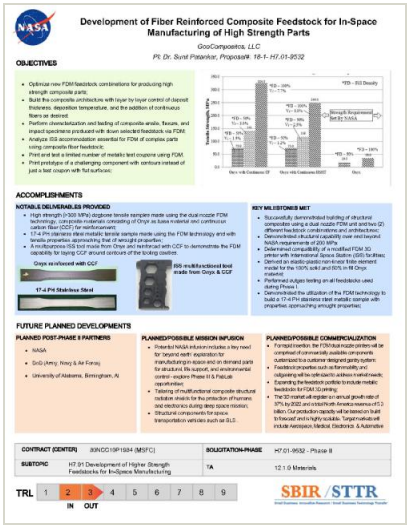

Final Summary Chart Image
Development of Fiber Reinforced Composite Feedstock for In-Space Manufacturing of High Strength Parts, Phase I
(https://techport.nasa.gov/image/133313)